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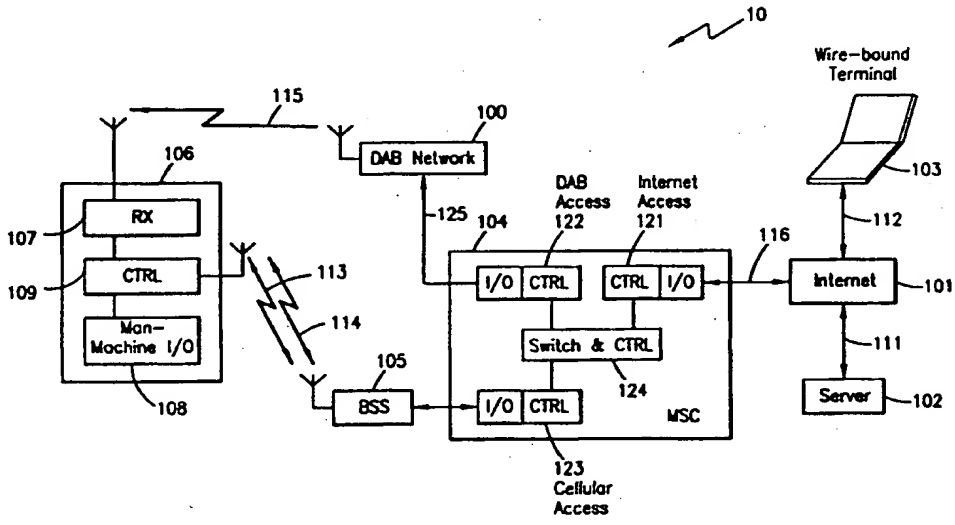

(57) Abstract

A method and system are disclosed for use with a mobile radio network, which receives and analyzes packets from a packet-switched fixed network (101), such as the Internet, and depending on the type of information received (e.g., speech, low speed data, or high speed WWW data), routes the information over an appropriate radio air interface to a mobile radio terminal. The speech information can be routed to mobile radio terminals over a conventional circuit-switched mobile radio link (e.g., a GSM traffic channel) (113), the low speed data can be routed over a packet-switched mobile radio link (e.g., a GPRS traffic data channel) (114), and the high speed data can be routed over a wideband broadcast radio link (e.g., a DAB network radio link) (115). As a result, mobile radio terminals can advantageously enjoy full access to the Internet and thereby communicate effectively over the Internet with other mobile and wirebound terminals.

INTERNET ACCESS FOR CELLULAR NETWORKS

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates in general to the telecommunications field and, in particular, to a method and apparatus for mobile radio telephone users to communicate via the Internet.

Description of Related Art

Today's cellular networks are designed to interconnect and interoperate with both Public Switched Telephone Networks (PSTNs) and Integrated Services Digital Networks (ISDNs). A common characteristic of these networks is that they are circuit-switched networks that handle relatively narrow bandwidth traffic.

In contrast, the rapidly growing "IP Network" or "Internet" is a packet-switched network which handles much wider bandwidth traffic than the circuit-switched networks. As such, most conventional wire-bound communications terminals are capable of fully utilizing the Internet's much wider bandwidths. However, a problem with using wireless (e.g., cellular) radio terminals to communicate with the Internet is that the wireless terminals are bandwidth limited by their respective radio air interfaces. A similar problem exists for Asynchronous Transmission Mode (ATM) or broadband ISDN communications systems, if these systems are being accessed by wireless radio terminals. Therefore, there is a need to overcome the bandwidth limitations of conventional wireless radio terminals, so that future wireless radio terminals can be utilized with packet-switched networks (or other wideband networks) to handle wideband traffic comparable to that handled by wire-bound terminals.

The air interface standards originally promulgated for cellular radio networks had been developed based on the use of specialized speech coding techniques. These coding techniques were optimized to allow the transmission of bit-effective, two-way speech traffic over the radio air interface. Subsequently, the air interface standards for cellular networks were modified to allow the transmission of relatively low speed data over the radio air interface. Now these standards also allow both the uplink and

For example, as mentioned above, one such problem is encountered when wide bandwidth traffic (e.g., from the Internet) is to be transmitted over the downlink radio air interface to a wireless radio terminal. Certain radio air interfaces, such as those used in the GSM and DAB systems, can provide the necessary downlink bandwidths required for typical applications used in packet-switched, land-based networks. However, the problem that remains is that there is no method available for use in combining the different interfaces involved.

In a cellular mobile radio network, a subscriber can "surf" the World-Wide Web (WWW) via the Internet by using a "laptop" personal computer (PC) as a radio terminal. The subscriber's search instructions can be readily conveyed over the uplink via the cellular network's radio air interface to a Mobile Services Switching Center (MSC). The instructions are then conveyed over the Internet via an Internet-connected server in accordance with the appropriate IP Standard protocol. However, in contrast, a much larger amount of information is conveyed over the downlink, and consequently, the process of transmitting such information over the radio link of a conventional cellular network is much too slow and thereby unacceptable to a subscriber, when compared to the much higher throughput of a typical wire-bound terminal.

The second problem is encountered when speech information is to be conveyed from a wireless radio terminal to the Internet. The transmission of speech information over a radio air interface is best accomplished by using a cellular circuit-switched connection. An example of such a connection is a Traffic Channel (TCH) in the GSM. On the other hand, the transmission of low speed data over a radio air interface is best accomplished by using a cellular packet-switched connection. An example of such a connection is a Packet Data Traffic Channel (PDTCH) in the GPRS. As such, while it is usually preferable to transmit speech and data over the air waves via different radio channels with specialized coding, the corresponding speech and data information can be conveyed over the Internet using a single packet data connection. Consequently, there appears to be no particular bandwidth problem for applications on the Internet that convey speech and low speed data. Nevertheless, there is still a problem associated with the process of selecting appropriate channels and procedures to be used

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the method and apparatus of the present invention may be had by reference to the following detailed description when taken in conjunction with the accompanying drawings wherein:

FIGURE 1 is a block diagram that illustrates an exemplary system that can be used to implement a preferred embodiment of the present invention; and

FIGURE 2 is a flow diagram of an exemplary method that illustrates how a system (such as that shown in FIGURE 1) can transfer information between a packet-switched network and a wireless radio terminal, in accordance with the preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

The preferred embodiment of the present invention and its advantages are best understood by referring to FIGUREs 1-2 of the drawings, like numerals being used for like and corresponding parts of the various drawings.

FIGURE 1 is a block diagram that illustrates an exemplary system that can be used to implement a preferred embodiment of the present invention. For this embodiment, system 10 includes a packet-switched network 101 (e.g., Internet). A WWW server 102 and a wire-bound terminal 103 (e.g., a personal computer) are connected for two-way communications by lines 111 and 112, respectively, to the packet-switched network 101. System 10 also includes a mobile communications network (e.g., a cellular radio network such as the GSM) which further includes a MSC 104, a base station subsystem (BSS) 105, and a wireless radio terminal 106.

The radio terminal 106 is coupled to BSS 105 via a first radio link (e.g., cellular air interface) for two-way communications therebetween. Preferably, the radio terminal includes a cellular control and transceiver subsection 109 (e.g., for the GSM) and a Digital Audio Broadcast (DAB) receiver subsection 107. The radio terminal can thereby receive both low speed data with the cellular transceiver (e.g., up to about 10-100 kbps for the GSM) and high speed data with the DAB receiver (e.g., up to about 1.5 Mbps for the DAB).

The MSC 104 is connected to a DAB network 100. Information from MSC 104 is coupled via a connection 125 to DAB network 100, which broadcasts this

The cellular air interface is denoted by two bi-directional arrows 113 and 114. Arrow 113 indicates a circuit-switched speech connection that, for example, uses a time slot on a pair (uplink and downlink) of carrier frequencies. Arrow 114 indicates a packet-switched data connection that, for example, uses another time slot on the same pair of carrier frequencies used by the speech connection. The DAB air interface is denoted by a uni-directional arrow 115, which indicates a downlink from the DAB network 100 to the radio terminal 106. A packet-switched connection 116 is shown between the MSC 104 and the packet-switched network 101. Connection 116 can be used to transfer information between the packet-switched network 101 and radio terminal 106, and also for communication between other radio terminals (not explicitly shown) served by MSC 104 and the packet-switched network. An example of a signalling protocol that can be used by the mobile station(s) and base station for use in switching between speech and data being conveyed over the radio air interface (links 113 and 114, respectively) is set forth in GSM Technical Specification 04.08.

FIGURE 2 is a flow diagram of an exemplary method that illustrates how a system (e.g., system 10 shown in FIGURE 1) can transfer information between a packet-switched network (e.g., Internet 101) and a wireless radio terminal (e.g., mobile terminal 106), in accordance with the preferred embodiment of the present invention. At step 201, a packet of information to be communicated is transferred from server 102 or terminal 103 via a respective communications line 111 or 112 to the packet-switched network 101. At step 203, the packet of information is transmitted from the packet-switched network 101 to access section 121 in MSC 104 via communications line 116. MSC 104 can also receive (via line 116) packets of information from other terminals (not explicitly shown), which are also connected to the packet-switched network and communicating with at least one wireless radio terminal (e.g., terminal 106) operating under the control of MSC 104. At step 205, switch and control section 124 in MSC 104 analyzes each packet received in access section 121, in order to determine what transmission path should be used to transfer the information packets from access section 121 to radio terminal 106.

At step 207, depending upon certain switching criteria and decisions made (to be described below), the switch and control section 124 determines whether to transfer

Returning to step 207, based on the above-described examples and any other appropriate switching criteria, if the switch and control section 124 selects the wideband (e.g., DAB) network route to transmit the received information packet(s), then at step 211, the MSC can convey a control message (e.g., over a GSM TCH via link 113 or a GPRS PDTCH via link 114) to the control section 109 of the radio terminal 106, which orders the radio terminal to switch on the receiver section 107. The MSC can resend this order at periodic intervals for as long as the wideband network route is selected. At step 213, the switch and control section 124 routes the received information packet (e.g., a WWW packet generated by server 102) from the packet-switched network access section 121, through the wideband (DAB) access section 122, and the wideband (DAB) network 100 broadcast transmitter (via link 115). The transmitted information packet is received and processed by the receiver section 107 in radio terminal 106. At step 215, when the information packet transmission is terminated (e.g., at server 102), the switch and control section 124 can transmit an order in a control message (e.g., via the GSM TCH or GPRS PDTCH) that directs the radio terminal control section 109 to switch off the receiver section 107. Alternatively, the radio terminal control section 109 can employ time-out circuitry (not explicitly shown) that switches off the receiver section under certain conditions after a predetermined amount of time.

Returning to step 207, if the packet-switched connection is selected, then at step 231, the information packet is reformatted in accordance with a standard packet-switched protocol (e.g., the GPRS standard is different than the IP network standard). At step 233, the reformatted packet is transmitted via the packet-switched connection (e.g., GPRS) to the radio terminal 106, in the time slot associated with the packet-switched radio link 114.

Returning again to step 207, if the circuit-switched connection (e.g., GSM) is selected, at step 221, the packet to be transmitted can be assumed to contain speech information and is, therefore, transcoded in the cellular transcoder section 123 into the speech code used in the circuit-switched network. At step 223, the transcoded packet is transmitted over the circuit-switched radio air interface (e.g., via a TCH in the GSM)

WHAT IS CLAIMED IS:

1. In a communication system comprising a packet-switched fixed network connected to a mobile radio network including a switch operable to route to a radio terminal information in at least one of a first code and second code, a method for optimizing transmission of the information from the packet-switched fixed network to the radio terminal, comprising the steps of:

said switch receiving from the packet-switched fixed network at least one packet of the information destined for the radio terminal, said packet coded according to a third code;

determining from said at least one packet of the information coded according to said third code, which of said first code or said second code is preferred for use in transmission of said packet over a radio link to said radio terminal;

transcoding said information coded according to said third code into said preferred first code or second code according to said step of determining; and

conveying said transcoded information over said radio link to said radio terminal.

2. The method according to Claim 1, wherein said packet-switched fixed network comprises an Internet.

3. The method according to Claim 1, wherein said mobile radio network comprises a GSM network.

4. The method according to Claim 1, wherein said first code comprises speech.

5. The method according to Claim 1, wherein said second code comprises low speed data.

6. The method according to Claim 1, wherein said switch comprises a mobile services switching center.

12. The method according to Claim 7, wherein said first radio interface comprises a GSM air interface.

13. The method according to Claim 7, wherein said second radio air interface comprises a Digital Audio Broadcast air interface.

14. The method according to Claim 7, wherein said predetermined type of the information comprises at least one of speech, slow data, and fast World Wide Web data.

15. The method according to Claim 7, wherein said second code comprises a standard Internet code.

16. In a communication system comprising a packet-switched fixed network connected to a mobile radio network including a switch and at least one radio terminal, said switch coupled to a broadcast network and operable to route to said radio terminal information over at least one of a plurality of radio interfaces, each one of said plurality of radio interfaces optimized for radio transmission of a predetermined type of the information, a method for optimizing transmission of the information from the packet-switched fixed network to the mobile radio network, comprising the steps of:

receiving by said switch a control message that directs said switch to route the predetermined type of the information over said at least one of said plurality of radio air interfaces;

transcoding the predetermined type of the information in accordance with a protocol of said at least one of said plurality of radio interfaces; and

routing said transcoded predetermined type of the information over said at least one of said plurality of radio interfaces.

17. The method according to Claim 16, wherein said packet-switched fixed network comprises an Internet.

routing the formatted information over said selected at least one of a plurality of radio links to the mobile radio terminal.

26. A system for use in routing information from a packet-switched fixed network to a mobile radio terminal, comprising:

access means for receiving a packet of the information in a mobile network associated with the mobile radio terminal;

a switch coupled to said access means and operable to select at least one of a plurality of radio links to route the information received to the mobile radio terminal;

formatting means for formatting the information received in accordance with a predetermined format associated with said selected at least one of a plurality of radio links; and

means for routing the formatted information over said selected at least one of a plurality of radio links to the mobile radio terminal.

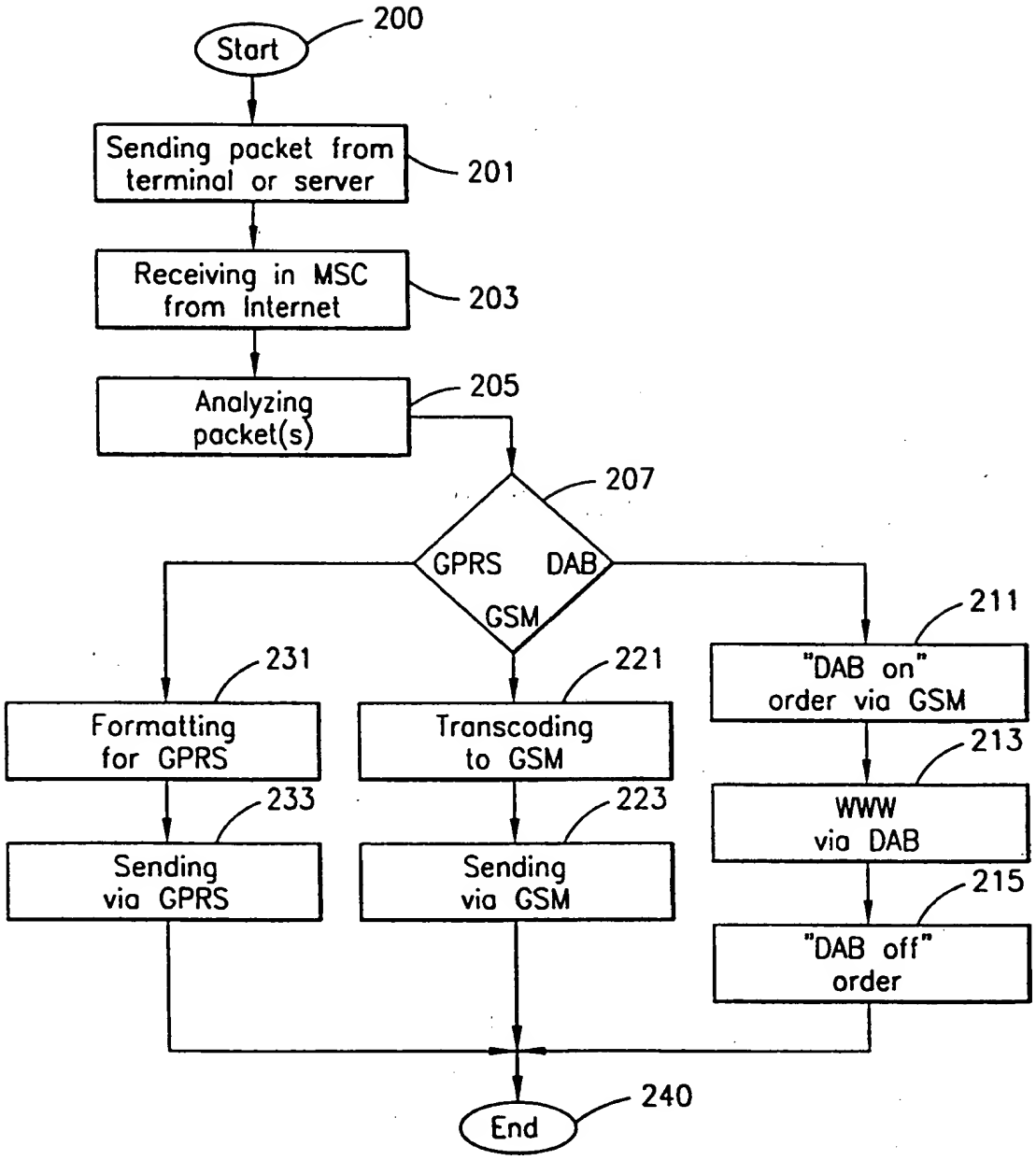

FIG. 2

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropnate, of the relevant passages	Relevant to claim No.
Y	US H1641 H (SHARMAN DUANE R) 1 April 1997 see column 3, line 43 - column 5, line 20 see column 6, line 25 - line 37 see column 8, line 49 - column 9, line 40 see column 10, line 1 - line 15 see column 12, line 25 - line 36 see column 13, line 59 - column 14, line 4 see column 16, line 1 - line 45	1-26
Y	EP 0 766 490 A (NOKIA MOBILE PHONES LTD) 2 April 1997 see page 3, line 49 - page 4, line 51	1-6,25, 26
Y	WO 97 02670 A (NOKIA TELECOMMUNICATIONS OY ;KASSLIN MIKA (FI); RINNE MIKA (FI); S) 23 January 1997 see abstract see claim 1	7-24
P,X	WO 97 28661 A (QUALCOMM INC) 7 August 1997 see the whole document	1,6,7, 11,16, 25,26
A	WO 97 12452 A (MOTOROLA INC) 3 April 1997 see page 4, line 15 - page 5, line 26 see page 7, line 33 - page 8, line 18	7-24
A	MELANCHUK T ET AL: "CDPD AND EMERGING DIGITAL CELLULAR SYSTEMS" DIGEST OF PAPERS OF COMPCON (COMPUTER SOCIETY CONFERENCE) 1996, TECHNOLOGIES FOR THE INFORMATION SUPERHIGHWAY SANTA CLARA, FEB. 25 - 28, 1996, no. CONF. 41, 25 February 1996, pages 2-8, XP000628458 INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS see the whole document	1-26
A	XYLOMENOS G ET AL: "IP MULTICAST FOR MOBILE HOSTS" IEEE COMMUNICATIONS MAGAZINE, vol. 35, no. 1, January 1997, pages 54-58, XP000683443 see the whole document	1-26
A	RADLHERR F: "DATENTRANSFER OHNE DRAHT UND TELEFON" FUNKSCHAU, vol. 62, no. 11, 25 May 1990, pages 49-52, XP000125313 see the whole document	1,7,16, 25,26

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